Factor Invariance of Psychometric Schizotypy in Spanish and American Samples

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Abstract:
The present study extended recent work examining the factor structure underlying the Wisconsin Schizotypy Scales by examining the factor invariance of this structure in Spanish and American nonclinical samples of young adults. A series of confirmatory factor analyses were conducted with 547 Spanish and 2,171 American young adults. Consistent with prior work, the best fitting model in both samples was a two-factor model with positive and negative schizotypy dimensions. Furthermore, the factor structure was invariant across the two samples. The findings support the construct validity of a multidimensional model of schizotypy and the use of psychometric inventories to assess these dimensions.

Keywords: Multidimensional | Schizophrenia | Psychometric screening | Confirmatory factor analysis | psychology

Article:

Schizophrenia and Schizotypy

Current etiological theories suggest that the underlying vulnerability for schizophrenia is expressed across a dynamic continuum of clinical and subclinical characteristics referred to as schizotypy (e.g., Claridge 1997; Meehl 1999; van Os and Kapur 2009). Since nonpsychotic schizotypes are hypothesized to share common neurodevelopmental pathways with schizophrenia patients, it is expected that they will exhibit mild and transient forms of the cognitive, emotional, and behavioral features of schizophrenia. Schizotypy is characterized as a multidimensional construct (Claridge et al. 1996; Mason et al. 1997; Raine et al. 1994; Stefanis et al. 2002; Vollema and van den Bosch 1995). Positive and negative symptom schizotypy are

the most consistently replicated factors (Kwapil et al. 2008). Positive schizotypy and positive symptom schizophrenia are characterized by odd beliefs and unusual perceptual experiences, which in their extreme form manifest as delusions and hallucinations. Negative schizotypy and schizophrenia are characterized by deficits such as affective flattening, anhedonia, social disinterest, and diminution of cognitive functioning. While there is not a universally agreed upon latent structure of schizotypy, the proposed factors are consistent with those hypothesized to comprise schizophrenia (Bilder et al. 1985; Liddle 1987; Peralta et al.1992), supporting the hypothesis that the vulnerability to schizophrenia is expressed across the continuum of schizotypy. Reliable identification of the factor structure of schizotypy and schizophrenia should facilitate the identification of etiological pathways and may guide development of treatment interventions.

Psychometric Assessment of Schizotypy

A number of psychometric inventories have been developed for assessing schizotypy in nonclinical samples. These relatively inexpensive and noninvasive measures can be used to screen large samples. Based upon Meehl's (1964) description of schizotypy, the Chapmans and their collaborators developed a series of self-report, true-false schizotypy questionnaires including the Perceptual Aberration (Chapman et al. 1978), Magical Ideation (Eckblad and Chapman 1983), Physical Anhedonia (Chapman et al. 1976) and Revised Social Anhedonia (Eckblad et al. 1982) Scales (referred to here as the Wisconsin Schizotypy Scales). These scales have been widely used in cross-sectional and longitudinal studies with psychotic patients and psychosis-prone subjects (e.g., Barrantes-Vidal et al. 2009; Barrantes-Vidal, Lewandowski, & Kwapil, 2010; Kaczorowski et al. 2009). Nonpsychotic individuals with markedly elevated scores on these scales tend to show psychological and physiological deficits similar to those seen in schizophrenia patients (see reviews in Edell 1995; Fernandes and Miller 1995; Fonseca-Pedrero et al. 2008) and are at heightened risk for developing schizophrenia-spectrum disorders (Chapman et al. 1994; Gooding et al. 2005; Kwapil 1998, Kwapil et al. 1997).

A number of studies have examined the factor structure underlying the Wisconsin Schizotypy Scales (e.g., Brown et al. 2008; Lewandowski et al. 2006). Kwapil et al. (2008) tested a series of competing models using confirmatory factor analyses in a sample of 6,137 young adults. As hypothesized, the best fit was reported for a two-factor model with positive and negative schizotypy factors. They reported that the Perceptual Aberration and Magical Ideation Scales loaded on the positive schizotypy factor and the two anhedonia scales loaded on the negative schizotypy factor. Consistent with previous reports, the Revised Social Anhedonia Scale also had a modest cross loading on the positive schizotypy factor. Kwapil et al. (2008) also provided support for the validity of the schizotypy dimensions based upon structured interviews of 430 young adults. Specifically, positive schizotypy was associated with interview ratings of psychotic-like, schizotypal, and paranoid symptoms, as well as impaired functioning, substance abuse, and mood disorders. Negative schizotypy was associated with schizotypal, schizoid, paranoid, and negative symptoms, and impairment in functioning.

Goals and Hypotheses of the Present Study

The present study examined the cross-cultural invariance of the factor structure of the Wisconsin Schizotypy Scales in large samples of Spanish and American young adults. The reliability and validity of Spanish translations of the schizotypy scales have been previously demonstrated (e.g., Barrantes-Vidal et al. 2003; Fonseca-Pedrero et al. 2009a; b). However, none of these studies has examined the factor structure underlying the measures. The finding of comparable factor structure in cross-cultural samples would lend further support to the continuum model of schizotypy and schizophrenia, and support the cross-cultural validity and utility of the Wisconsin Schizotypy Scales. Specifically, it was hypothesized that the two-factor structure reported in Kwapil et al. (2008) would provide the best fit for the data from both samples. Furthermore, it was hypothesized that the factor structure would be invariant between the samples under increasingly restrictive conditions.

Method

Participants

Both the Spanish and American participants volunteered to take part in the study for course credit and were not pre-selected based upon any criteria. The Spanish sample included 547 students (456 women, 92 men) recruited from the Universitat Autònoma de Barcelona out of a candidate pool of approximately 750 participants (73%). Mean age of the sample was 20.7 (SD = 4.6). The American sample included 2,171 students (1,655 women, 516 men) recruited from the University of North Carolina at Greensboro out of a candidate pool of approximately 3,500 participants (62%). Mean age of the sample was 19.6 (SD = 3.3). Note that the American sample did not include any participants in the sample of 6,137 reported by Kwapil et al. (2008).

Materials and Procedures

Participants in both samples were administered the Perceptual Aberration, Magical Ideation, Revised Social Anhedonia, and Physical Anhedonia Scales. Participants in Barcelona completed Spanish translations of the scales described in Ros-Morente et al. (2010). The items on the schizotypy scales were intermixed with a 13-item measure of infrequent responding (Chapman and Chapman 1983). The infrequency scale was included to screen out participants who responded in a random or “fake-bad” manner (e.g., I cannot remember a time when I talked with someone who wore glasses). Consistent with the recommendations of Chapman and Chapman, participants who endorsed more than two infrequency items were dropped from further study. Participants completed these measures (along with measures not used in this study) as part of mass-screening sessions that lasted 1 to 2 h.

Results

Descriptive and Correlational Analyses for the Schizotypy Scales

Table 1 contains descriptive statistics for each of the schizotypy scales in the two samples. Scores on each of the scales were significantly higher for the American sample. Note that the large sample size renders the interpretation of statistical significance problematic because even trivial differences can be statistically significant. Therefore, effect sizes (Cohen's d) are reported for the analyses. Following Cohen (1992), an effect size of .8 is considered large, .5 is considered medium, and .2 is considered small. Table 2 presents the correlations of the schizotypy scales in the two samples (correlations of .1 indicate small, .3 medium, and .5 large effect sizes). Note that the pattern of correlations between the samples was comparable, despite the mean differences. Furthermore, the correlations for the American sample were virtually identical to those reported for the American sample in Kwapil et al. (2008).

Table 1 Descriptive statistics for the schizotypy scales in the Spanish (n = 547) and American (n = 2171) samples

Measure	Spanish Sample				American Sample				*t*-value	Cohen's *d*
	Mean	SD	Range	Alpha	Mean	SD	Range	Alpha		
Perceptual Aberration	3.9	4.0	0–26	.84	5.6	5.2	0–34	.87	7.40	.38
Magical Ideation	5.7	4.5	0–24	.81	9.0	5.5	0–29	.83	13.03	.66
Physical Anhedonia	12.6	6.1	0–42	.79	13.9	7.0	0–47	.83	3.76	.19
Rev. Social Anhedonia	6.8	5.2	0–36	.84	9.3	5.8	0–39	.84	8.87	.44

All comparisons, $p < .001$

Table 2 Pearson correlations of the schizotypy scales in the Spanish ($n = 547$) and American ($n = 2171$) samples

	Perceptual Aberration	Magical Ideation	Physical Anhedonia	Revised Social Anhedonia
Spanish Sample				
Perceptual Aberration	–			
Magical Ideation	***.64***	–		
Physical Anhedonia	−.02	−.06	–	
Revised Social Anhedonia	.24	.20	**.35**	–
American Sample				
Perceptual Aberration	–			
Magical Ideation	***.68***	–		
Physical Anhedonia	−.05	−.13	–	
Revised Social Anhedonia	.29	.22	**.41**	–

Medium effect sizes in bold, large effect sizes in bold and italics

Confirmatory Factor Analyses

Confirmatory factor analyses (CFAs) were conducted using AMOS 18 (Arbuckle 2009) to examine the factor structure of psychometrically assessed schizotypy in the Spanish and American samples. The sample size and the number of participants per observable variable were more than sufficient for conducting CFA, with each sample having greater than a 20:1 participant to observed variable ratio (Anderson and Gerbing 1984; Bentler and Chou1987) and being well above the 200 participant minimum recommended by Barrett (2007). Following the recommendations of Little et al. (2002) and Coffman and McCallum (2005), each of the scales was divided into three "parcels" in order to produce more robust estimates. Parcels were computed by randomly distributing groups of three items to the parcels in sequential order to ensure that each parcel contained a comparable proportion of items from the beginning, middle, and end of the scale. The residuals from each parcel within a schizotypy scale were allowed to correlate given the common source. Goodness of fit was assessed using multiple indicators listed in Table 3, including the Goodness of Fit Index (GFI), Adjusted GFI (AGFI), Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and the chi-square statistic. Adequate fit of the model to the data is generally indicated by fit indices greater than .95, RMSEA less than .05, and nonsignificant chi-squares (see Kline [2011] for a full discussion of interpreting fit statistics); however, with a large sample, it is unlikely to find a nonsignificant chi-square value. As an alternative method of comparing competing models, the Akaike Information Criterion (AIC) and Browne-Cudeck Criterion (BCC), two information-theory approaches to model fit, were included. Models with smaller values of BCC and AIC have better fit than competing models (Kline 2011). In the case of nested models, change in chi-square and change in degrees of freedom across models was examined (with statistical significance indicating improved fit). Note, however, this was not examined for the assessment of factor invariance, given Cheung and Rensvold's (2002) concerns it is not an appropriate test of factor invariance in large samples, because the test statistic can be statistically significant even when the changes in parameter estimates are trivial.

Table 3 Confirmatory factor analyses of schizotypy scale parcels in the Spanish ($n = 547$) and American ($n = 2171$) samples

Model	**GFI**	**AGFI**	**CFI**	**RMSEA**	**95%CI**	**AIC**	**BCC**	**Chi-square (df)**	***p*-value**	**$\Delta\chi^2$ (Δdf)**	***p*-value**
Spanish Sample											
Unidimensional	.90	.82	.91	.103	.092–.114	360.4	362.1	290.4 (43)	< .001		
Two-Factor[a]	.97	.94	.98	.055	.043–.067	182.9	184.6	110.9 (42)	< .001		
Two-Factor[b]	.98	.95	.99	.043	.029–.057	156.7	156.6	78.7 (39)	< .001	32.2 (3)	< .001
American Sample											

Model	GFI	AGFI	CFI	RMSEA	95%CI	AIC	BCC	Chi-square (df)	*p*-value	$\Delta\chi^2$ (Δdf)	*p*-value
Unidimensional	.91	.83	.92	.107	.102–.113	1189.4	1189.8	1119.4 (43)	< .001		
Two-Factor[a]	.98	.96	.98	.055	.050–.061	393.1	393.5	321.1 (42)	< .001		
Two-Factor[b]	.99	.98	.99	.029	.023–.036	189.3	189.8	111.3 (39)	< .001	209.8 (3)	< .001

[a]Positive schizotypy factor (with loadings from the Perceptual Aberration and Magical Ideation Scales); Negative schizotypy factor (with loadings from the Revised Social Anhedonia and Physical Anhedonia Scales)
[b]Positive schizotypy factor (with loadings from the Perceptual Aberration, Magical Ideation and Revised Social Anhedonia Scales); Negative schizotypy factor (with loadings from the Revised Social Anhedonia and Physical Anhedonia Scales)
GFI Goodness of Fit Index, *AGFI* Adjusted Goodness of Fit Index, *CFI* Comparative Fit Index, *RMSEA* Root Mean Square Error of Approximation, *AIC* Akaike Information Criterion, *BCC* Browne-Cudeck Criterion

Table 4 Invariance of the factor structure across the Spanish ($n = 547$) and American ($n = 2171$) samples for the final two-factor model

Model	GFI	AGFI	CFI	RMSEA	95% CI	AIC	BCC	Chi-square (df)	*p*-value
Unconstrained	.99	.98	.99	.023	.019-.027	346.1	348.5	190.1 (78)	< .001
Regression Weights Constrained	.99	.98	.99	.024	.021–.028	367.6	369.6	237.6 (91)	< .001
Structural Covariances Constrained	.98	.97	.99	.028	.024–.032	418.6	420.5	294.6 (93)	< .001

GFI Goodness of Fit Index, *AGFI* Adjusted Goodness of Fit Index, *CFI* Comparative Fit Index, *RMSEA* Root Mean Square Error of Approximation, *AIC* Akaike Information Criterion, *BCC* Browne-Cudeck Criterion

Three models were tested to examine factor structure. These models were computed separately for the Spanish and American samples. The first (default) model did not differentiate an underlying factor structure for schizotypy—all the variables loaded on a generic schizotypy factor. As seen in Table 3, the fit for this model was poor for both samples. The second model included a positive schizotypy factor with loadings from the Perceptual Aberration and Magical Ideation Scale parcels, and a negative schizotypy factor with loadings from the Revised Social Anhedonia and Physical Anhedonia Scale parcels. The schizotypy factors were allowed to correlate in this and the subsequent models. This model provided improved fit for the data. The final model was the same as the previous, except that the Revised Social Anhedonia Scale was

allowed to load on both of the schizotypy factors (consistent with Kwapil et al. 2008). This two-factor model provided excellent fit for the data. Given that the final two models were nested, the change in chi-square and degrees of freedom was evaluated between them. The final model provided significantly improved fit over the second model. Factor loadings in the two samples for the final model are reported in Table 5.

Table 5 Standardized factor loadings for the schizotypy parcels in the Spanish ($n = 547$) and American ($n = 2171$) samples for the final two-factor model

	Schizotypy	Spanish	American
Parcel	**Factor**	**Sample**	**Sample**
Magical Ideation 1	Positive	.69	.73
Magical Ideation 2	Positive	.69	.74
Magical Ideation 3	Positive	.71	.77
Perceptual Aberration 1	Positive	.66	.73
Perceptual Aberration 2	Positive	.76	.73
Perceptual Aberration 3	Positive	.63	.66
Social Anhedonia 1	Positive	.28	.39
Social Anhedonia 2	Positive	.16	.35
Social Anhedonia 3	Positive	.26	.36
Social Anhedonia 1	Negative	.59	.66
Social Anhedonia 2	Negative	.69	.60
Social Anhedonia 3	Negative	.48	.55
Physical Anhedonia 1	Negative	.31	.54
Physical Anhedonia 2	Negative	.46	.52
Physical Anhedonia 3	Negative	.54	.63

In order to test the invariance of the factor structure across the Spanish and American samples, a multi-group, multi-model comparison was conducted using the final two-factor structure solution reported above. In the first model, the subscales were allowed to freely load on the schizotypy factors for each of the two samples. In the second model, the regression weights (but not the structural covariances) were constrained to be identical across the two groups. The final model was the most restrictive in that it constrained the factor variances and covariances, in addition to the regression weights, across the two groups. As seen in Table 4, the two constrained models fit the data equally as well as the model in which the factor loadings were allowed to vary freely, supporting the comparability of the factor structure of psychometrically assessed schizotypy in the Spanish and American samples. Not surprisingly, the unconstrained model had the best fit, because the unconstrained model allows parameters to be freely estimated within the samples. However, even under the most restrictive conditions of invariance, the model fit was excellent.

Discussion

Invariance of Factor Structure in the Spanish and American Samples

The present study built upon recent factor studies of psychometrically identified schizotypy and provided preliminary evidence of cross-cultural factor invariance. Both the Spanish and American samples were characterized by a two-factor structure that is consistent with reports by Brown et al. (2008), Kwapil et al. (2008), and Lewandowski et al. (2006). Furthermore, even under restrictive conditions, the model fit was comparable for the Spanish and American samples. The present findings also provided additional evidence regarding the psychometric consistency of the Wisconsin Schizotypy Scales. The means, standard deviations, reliability, correlations, and factor structure of the scales in the American sample were strikingly similar to values reported in other American samples (e.g., Chapman et al. 1982; Kwapil et al. 2008; Kwapil et al. 2002; Winterstein et al. 2010). Likewise, the reliability, correlations, and factor structure of the scales were comparable between the Spanish and American samples.

The finding that the means for the Spanish sample fell from 1/5th to 2/3rds of a standard deviation below the American sample was unexpected and the reason is not clear. It did not result from incomplete questionnaires, as the data were complete for all the questionnaires. The Spanish sample contained a larger proportion of female participants than the American sample However, this would not explain the differences on Perceptual Aberration and Magical Ideation, as positive schizotypy scores tend to be higher in female participants, although it could have contributed to the differences on anhedonia. The mean scores on the Perceptual Aberration, Magical Ideation, and Physical Anhedonia Scales for the Spanish sample in the present study were also somewhat lower than the means reported by Fonseca-Pedrero et al. (2009a, b) for a sample of approximately 700 Spanish college students from the University of Oviedo. Nevertheless, the factor structure of the measures was invariant across our samples. However, the findings suggest that researchers may need to establish local norms for the measures.

Consistent with previous findings (e.g., Brown et al. 2008; Kwapil et al. 2008; Lewandowski et al. 2006), the Revised Social Anhedonia Scale had a modest cross-loading with the positive schizotypy factor in the best fitting model. Kwapil et al. (2008) discussed this finding and concluded that it represents that the scale inadvertently taps affective dysregulation and social anxiety, in addition to its primary loadings on negative schizotypy—a finding seen in both the Spanish and American samples in the present study. The consistency of this finding across different samples suggests that future psychometric work should attempt to discriminate between social anhedonia, social anxiety, and social discomfort in this scale.

The literature suggests that the Wisconsin Schizotypy Scales reliably tap two underlying dimensions and that these dimensions are differentially related to aspects of schizophrenia-spectrum psychopathology. Kwapil et al. (2008) reported that the positive schizotypy dimension was associated with interview ratings of psychotic-like, schizotypal, and paranoid symptoms, as well as poorer overall functioning, mood episodes, substance abuse, and mental health treatment in a non-clinically ascertained sample. They reported that negative schizotypy was associated with interview-based schizotypal, schizoid, paranoid, and negative symptoms, as well as poorer

psychosocial functioning. These findings are consistent with the positive (psychotic) and negative (deficit) symptom dimensions described in schizophrenia. However, cross-cultural validation of these schizotypy dimensions is still required. Note that our focus on and identification of the positive and negative schizotypy dimensions is limited by the nature of the measures administered. We did not test any models with more than two factors because meaningful hypotheses could not be offered supporting three or four-factor models using these questionnaires. However, we believe that identification and validation of additional dimensions (e.g., paranoia, cognitive and behavioral disorganization) are essential for furthering our understanding of schizotypy.

Utility of Schizotypy for Understanding Schizophrenia

Current etiological models suggest that schizophrenia and spectrum disorders are the most extreme manifestations of a broader continuum of risk referred to as schizotypy. Schizotypy appears to offer a promising construct for understanding the etiology and development of schizophrenia-spectrum disorders. Target endophenotypes map nicely to the schizotypic continuum. Furthermore, subclinical manifestations such as the prodrome (e.g., McGorry et al. 2003) and the Attenuated Psychotic Symptoms Syndrome proposed for DSM-5 (American Psychiatric Association 2010) are presumed to be subsumed within schizotypy (as are schizophrenia-spectrum disorders). Schizotypy is also a useful basis for examining cross-cultural expression of schizophrenic psychopathology, because it minimizes many of the confounding and comorbid factors present in schizophrenia (e.g., hospitalization, psychotropic medications, marginalized social status) and because the use of nonclinical samples can avoid the diagnostic bias that occurs in patient samples (Chin and Kameoka 2006) such as African Americans (see review in Lawson 2008). Note that Chapman et al. (1995) recommended that investigators determine whether separate norms are needed for participants of different backgrounds. For example, Chmielewski et al. (1995) supported the use of different norms for different ethnic groups among American college students, whereas Kwapil et al. (2008) suggested that different norms were not warranted.

Psychometric measures of schizotypy offer a promising method of tapping schizotypic characteristics and identifying putative schizotypes. Longitudinal studies suggest that both individually and in conjunction with other indices, the psychometric measures provide effect sizes comparable to studies of consanguinity in the prediction of the development of schizophrenia-spectrum disorders (Chapman et al. 1994; Kwapil 1998). However, a necessary step in the validation of such models is examining the extent to which schizotypy and its factor structure is invariant across cultures. Likewise, the cross-culture validation of measures of schizotypy is essential.

Future Study and Validation

The present results provide a preliminary step in the examination of cross-cultural factor invariance of psychometrically assessed schizotypy. The next steps are to expand the examination to gender-balanced samples, samples with a wider age range, additional cultures, including nonwestern cultures, to examine broader demographic groups and socio-cultural

characteristics (e.g., Lin and Kleinman 1988), and to validate the psychometrically identified positive and negative schizotypy dimensions in cross-cultural studies. The present study will hopefully spur continued cross-cultural construct validation of the schizotypy continuum, keeping in mind Kleinman's (1987) admonishment that, "Validation is not simply verification of concepts used to explain observations. Rather it is as well verification of the meaning of the observations in a particular social system" (p. 453). As such, future studies should ultimately examine the links between specific cultural characteristics and the expression of psychopathology (Draguns and Tanaka-Matsumi 2003).

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